

# Climate & Air Quality Inventory Improvement & Database Management for Developing Countries

The International Sustainable Systems  
Research Center (ISSRC)



September 29, 2010

# Purpose

Help developing countries build a management process that achieves sustainable air quality improvements

## Keys To Success

- ✧ Adoption of a well designed air quality improvement policy
- ✧ A government infrastructure with the knowledge and tools to effectively implement that policy

# Air Quality Improvement is Complex

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- ✧ Overlap between media and governmental organizations
- ✧ Multiple targets for improvement
- ✧ Evolving 'targets'
  - ✧ Criteria, chlorofluorocarbons, acid deposition, toxics, climate change, more to come?
- ✧ Varying scales – spatial, temporal
- ✧ Interactions among pollutants
- ✧ Unknown sources

# Learning from the U.S. Experience

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- ✧ Clean Air Acts of 1970/1977
  - ✧ Set Air quality standards
  - ✧ Set Attainment deadlines
  - ✧ Penalties for non-attainment
- ✧ Slower air quality improvement than originally expected
- ✧ There are still major metropolitan areas that do not meet the standards set in the 1970s today

# *Why?!*

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Partly, because:

- ✧ Focus on the wrong pollutants
- ✧ Lacked the ability to adequately project emissions and their impacts ...led to ignoring:
  - ✧ key emissions sources
  - ✧ cultural trends
- ✧ Resulted in less effective air quality management plans focusing on one pollutant at a time

# Some of the Same Hurdles for Developing Countries Today

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- ✧ Chongqing, Guadalajara, Sao Paulo, Shanghai have primarily point source inventories
- ✧ Little ability to understand overall sources of pollution or predict future trends
- ✧ Have no way to update or improve their pollution related information
- ✧ Difficult to compare, select and provide accurate justification of various potential policies and any potential adverse impacts.

# ISSRC Identified 3 Areas to Try and Make an Initial Contribution

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1. Provide a tool to estimate on-road mobile source emissions
2. Make available information designed to help developing countries implement their air quality management policies
3. Create a system to manage complex environmental related data to allow for effective and meaningful air quality improvement plan development

# Partners to Date

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- ✧ U.S. EPA
- ✧ Hewlett Foundation
- ✧ The Energy Foundation
- ✧ World Bank
- ✧ EMBARQ--World Resource Institute





# 1. The International Vehicle Emissions Model (IVE)

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- ✧ Estimate emissions for passenger cars, trucks, buses, three- and two-wheel vehicles for important urban pollutants, toxics, and global warming gases
- ✧ Includes gasoline, diesel, natural gas, propane, and alcohol fueled vehicles
- ✧ Incorporates a straightforward methodology to collect the needed modeling information
- ✧ Allow users a way to update the emission factors when local data is available and adapt to the local situation

# IVE Model & Implementation Status

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- ✧ First Release in 2003, last update in May 2010
- ✧ Available free on the internet
- ✧ Refined data collection methodology (snapshot of vehicle activity, driving patterns and starts, and in-use emissions in any remote location)
  - ✧ 2-3 weeks in field, reasonable costs
  - ✧ All major vehicle types covered
  - ✧ Laboratory not required
- ✧ Field studies have resulted in 15 location specific information to supplement the base IVE model (also available on website).



# IVE Model Highlights & Progress

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- ✧ 1500 registered users from air quality agencies and universities around the world
- ✧ In use in sixteen countries (that we know of)
- ✧ Recommended by INE to be the national model for calculating emissions in Mexico
- ✧ Used along with several other models as the basis of the national model for vehicles in China
- ✧ Reviewed along with other important emission models (February, 2009 AWMA Journal)
  - ✧ Rated: Easiest to use model/Most accurate model for developing countries
  - ✧ Compared with: U.S.EPA Mobile, California EMFAC, European COPERT model and others.

# IVE Operates in Five Languages

The image displays three overlapping screenshots of the IVE Model 2.0 software interface, demonstrating its multilingual capabilities. The top-left screenshot shows the English version, the top-right shows the Russian version, and the bottom-center shows the Chinese version.

**English Version (Top Left):** The interface is titled "International Vehicle Emissions Model". It features tabs for "Calculation", "Location", "Fleet", and "Base Adjustments". The "Location" tab is active, showing a "Location Group" dropdown set to "single location" and a list of "Available Locations" including Istanbul bus, commercial car, dolmus, heavy truck, medium truck, PCAR Asia, and PCAR COEU. Buttons for "Add" and "Remove" are present. The bottom section shows "Results" for "Start-up Hour", "Running Hour", and "Total Hour" for various pollutants (CO, VOC, VOC evap.).

**Russian Version (Top Right):** The interface is titled "ВЫБРОСЫ АВТОТРАНСПОРТНЫХ СРЕДСТВ В АТМОСФЕРУ (международная модель)". It features tabs for "Вычисления", "Локализация", "Парк АТС", and "Корректировка". The "Локализация" tab is active, showing a "Группа объектов" dropdown set to "отдельный объект" and a list of "Доступные объекты" including Istanbul bus, commercial car, dolmus, heavy truck, medium truck, PCAR Asia, PCAR COEU, PCAR HIEU, PCAR LIEU, PCAR LIEU, PCAR LIEU, and PCAR LIEU. Buttons for "Добавить" and "Удалить" are present. The bottom section shows "ВЫБРОСЫ" (Emissions) for "пусковые, в час", "пробеговые, в час", and "общие, в час" for various pollutants (CO, VOC, VOC evap., NOx, SOx, PM).

**Chinese Version (Bottom Center):** The interface is titled "全球机动车排放模型". It features tabs for "计算", "工况", "排放", and "显示". The "计算" tab is active, showing a "工况组" dropdown set to "单一工况" and a list of "计算工况" including LA-4 cycle (Bag2&3 of FTP) (Pre 1995 Chongqing). Buttons for "添加" and "删除" are present. The bottom section shows "计算结果" (Calculation Results) for "小时启动排放", "小时行驶排放", and "小时总排放" for various pollutants (CO, VOC, VOC evap., NOx, SOx, PM).

# IVE in the Future

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- ✧ Add Black Carbon emission factors
- ✧ Provide a way to distribute emissions over a grid system to support air quality modeling
- ✧ Add off-road mobile sources
- ✧ Continually update emission factors, add new vehicles, and update driving and other adjustments as scientific research provides new data
- ✧ Would like to add Portuguese and Turkish as supported languages

## 2. Air Quality Management (AQM) Handbook

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✧ A free internet-based information system on how to carry out effective air quality management

✧ 4 topics to date [www.aqbook.org](http://www.aqbook.org)

✧ English, with some in Spanish and Chinese.

✧ Can be updated remotely by approved participants.

✧ Used by governments, Universities, and training institutes.



# AQM Handbook Status

- ✧ Work in Progress.. More chapters to come
- ✧ Will convert to text books where appropriate
- ✧ Find volunteer editors from retired air quality professionals to help

Developing a Framework for Effective Air Quality Management

http://www.aqbook.org/read/?page=61

MySQL Documentation AQ Book CA Online Cert Translate Spanish Dictionary Emission Inv...rk | US EPA UTSports

## CHAPTER 3

### DEVELOPING A FRAMEWORK FOR EFFECTIVE AIR QUALITY MANAGEMENT

#### Developing a Framework for Effective Air Quality Management

##### 3.1 Introduction

Since recognizing the deteriorating air quality in urban areas, governments around the world have worked to develop air quality management programs designed to produce and maintain clean air. The efforts started in developed countries in earnest in the 1950s after the "London Killer Smog", which took the lives of thousands of people in just a few days. The "Donora Air Pollution Emergency" in the 1950s killed hundreds of people in a matter of days in the United States and increased the emphasis on addressing air quality there. Some of the air quality programs begun in the 1950s have successfully reduced levels of air pollution. Unfortunately, programs in many locations have done little to improve air quality even after decades of effort. Clearly, regions seeking to effectively protect and improve their air quality are best advised to emulate those locations that have proved to be successful in reducing air pollution and to try to avoid the mistakes of those areas which have made little or no progress. However, it is important to distinguish the framework from the plan itself. While it is often advantageous to use a successful framework and apply it to a different area, it is not recommended to duplicate the plan itself used in one area for another. This can result in invalid assumptions on the importance of one source over the other and ineffective and costly reductions in emissions.

London, England was forced to address its air quality after the London killer smog and has made considerable progress in this respect since the 1950s. Los Angeles, California, as another example, started their program in the late 1940s and ultimately produced one of the more aggressive and successful clean air efforts in the world.

Actions to address air quality problems in developing countries did not begin typically until the 1970s and in many cases not until the early 1990s and even later. Sao Paulo, Brazil adopted air pollution control legislation in the mid-1970s. Mexico City, which may have had the worst air pollution in the world in the late 1980s, and Santiago, Chile, which had a significant air quality problem as well in the same timeframe, have implemented successful air quality management programs in their respective areas beginning in the late 1980s. Clearly, many developing countries are operating in a catch-up mode compared to developed countries and cannot be expected to solve air quality problems over night. It has taken places like Great Britain and the United States thirty-five years to achieve the air quality improvement visible today, and air quality continues to be unacceptable in many parts of both the

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Spanish

English

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为一个区域设立空气质量目标

http://www.aqbook.org/read/?page=61&language=Ch

MySQL Documentation AQ Book CA Online Cert Translate Spanish Dictionary Emission Inv...rk | US EPA UTSports

## 章节 3

### 为一个区域设立空气质量目标

#### 为一个区域设立空气质量目标

##### 3.1 引言

自从认识到城区的空气质量在不断恶化，世界各国的政府就开始发展旨在供给、维持清洁空气的大气质量管理计划。发达国家真正的努力始于20世纪50年代的“伦敦烟雾事件”之后，在那短短的几天中就有上千人失去生命。美国同时期的“多诺拉大气污染事件”再一次在几天之内使数百人丧命，这更增加了解决大气质量问题的紧迫性。20世纪50年代开展起来的一些大气质量改善计划已成功降低了空气污染的程度。然而不幸的是，此类计划在很多地区执行数十年之后仍然收效甚微。显然，欲求有效维持并提高空气质量的地区应该效仿那些确实证明成功缓解了大气污染的地区，而要避免无功而返的地区所犯的错误。然而，很重要的一点是要将整体框架和具体方案区分开。虽然把成功的框架模式运用到其他地区通常是有利的，但把一个地区的具体做法完全复制到另一个地区上面则是行不通的。若是这样就错误的假定了不同污染源的严重程度，从而造成低效且代价高昂的减排措施。

英国伦敦在发生了伦敦烟雾事件之后不得不采取措施改善空气质量，从20世纪50年代以来，已取得了显著的成效。加州的洛杉矶市另外一个改善空气质量的例子，从20世纪40年代启动空气质量计划以来，逐步建立了全世界最为有效的清洁空气行动之一。

20世纪70年代发展中国家才开始采取针对空气质量问题的措施，且在一些国家直到20世纪90年代甚至更晚才开始。巴西的圣保罗在20世纪70年代中期在控制空气污染方面进行立法。20世纪80年代晚期墨西哥城世界空气污染最为严重的墨西哥城以及同一时期同样有着严重空气质量问题的智利圣地亚哥开始成功的在各自相关的领域中实施空气质量控制方案。显然，与发达国家相比许多发展中国家采取的是种追赶的模式，但也不可能一夜之间解决所有的空气质量问题。在英国和美国等国家，取得今天可见的空气质量进步用了三十五年时间，然而在这些国家还有许多地方情况还是难以让人接受。当发达国家用几十年的时间取得重大的进步时，其它的一些发展中国家在发达国家成功的基础上在其地区内飞速发展，例如墨西哥城和智利的圣地亚哥在十七年的时间里取得了重大的进步。

英国伦敦努力的结果是使伦敦的空气质量多数达标，并且使被煤烟污染变黑的建筑恢复了本来的颜色。但是，对于英国被酸雨和酸雨腐蚀了的历史纪念碑，却无计可施。由于对历史纪念碑的损坏以及人体健康难以被还原，这就提醒人们需要尽快治理空气污染。洛杉矶的臭氧浓度从1977年降低至75%后，平均每十年降低50%。墨西哥城和圣地亚哥的污染从1990年起也减轻了一半。这些地区的经验可以用于指导其它地区建立起行之有效的空气质量管理体系。

空气质量问题的影响范围小至几平方公里，大到上千平方公里，跨越数十个城市和省界形成区域性，甚至超越国界。最终有可能成为全球性问题，需要许多国家协同努力才能解决。

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### 3. The IED (International Environmental Database)

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- ✧ Database system to manage air quality/energy related information
- ✧ Calculate and project air quality emissions, energy requirements, fuel use for urban regions
- ✧ Integrate policy analysis for urban air, water, solid waste, and climate change pollution



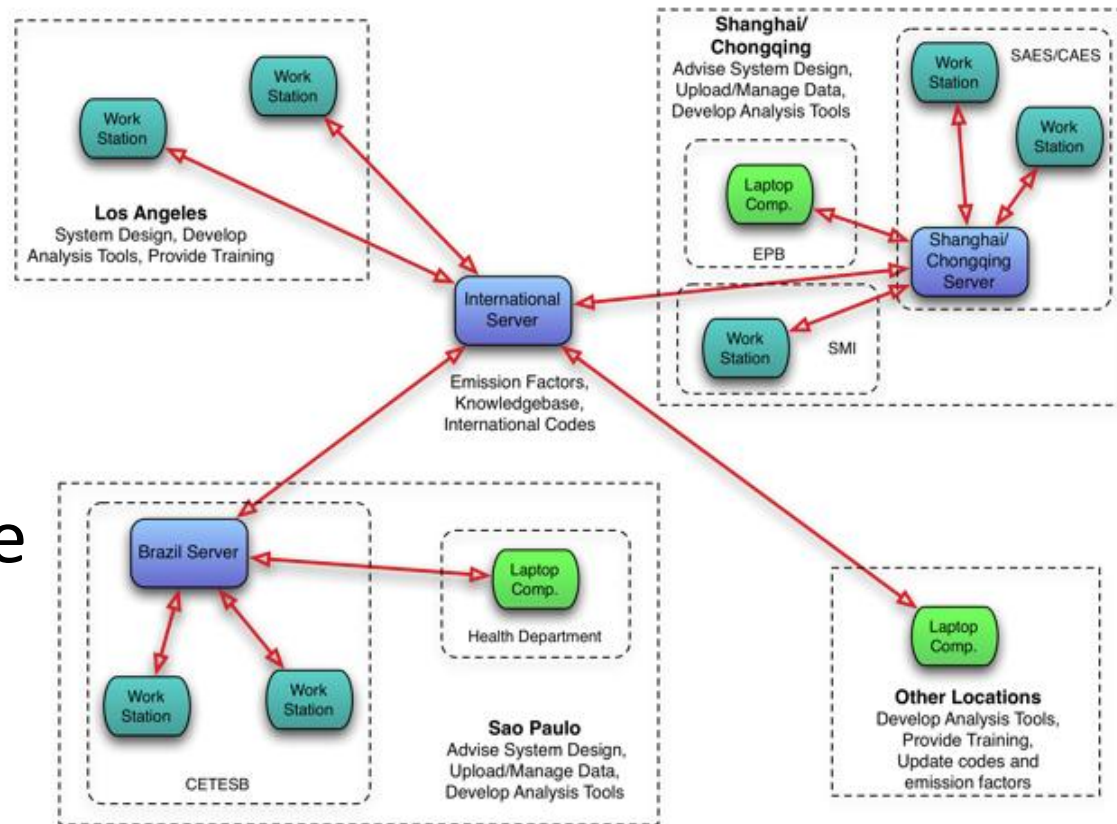
International Environmental Database

Metropolis



# IED Design Requirements

- ✧ Allow businesses to update their own information
- ✧ Support source enforcement
- ✧ Support emission caps and credit trading
- ✧ Remotely accessible
- ✧ Available free
- ✧ Secure & Flexible



# IED System Implementation Status

- ✧ Base system created
- ✧ Implementing in Mexico City, Guadalajara and Chongqing
- ✧ Several other areas in discussion

计算源流程

English | Español | Português | 汉语

国际环境数据库  
大都会市

计算源流程

年: 2010 基础劣化年: 使用默认年份 基础增长年: 使用默认年份

季节: 一至三月工作日 小时: 日总量

所有源: 单个源: 单个工艺:

源代码: 30000

所有流程: 仅空气污染物:

物质: 氮氧化物 (NO<sub>x</sub>)

计算

源名称: Passenger Vehicles  
地区: Metropolitan Region of Metropolis  
流程物质: 氮氧化物 (NO<sub>x</sub>)  
计算时间: 2010 - 一至三月工作日 - 日总量  
工艺数目: 22  
区域的总排放: 35746 kg

	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
19	15.34	15.08	15.34	15.34	30.86	46.46	62.26	94.73	15.69	197.9	45.98	61.64	61.64	197.9	61.19	93.11	93.11	61.19	93.88	45.98
18	15.34	15.08	15.34	15.34	30.86	46.46	62.26	94.73	46.54	93.88	196.0	61.19	61.19	61.19	196.0	61.19	61.19	93.88	45.98	15.37
17	30.76	30.23	15.34	30.86	46.46	95.51	94.73	46.54	93.88	196.0	61.19	61.19	61.19	61.19	196.0	61.19	61.19	93.88	45.98	15.37
16	15.03	30.14	30.14	46.46	95.51	62.71	47.36	93.88	95.62	223.1	93.11	93.11	93.11	109.6	164.1	45.67	45.98	30.33	0.0	0.0
15	15.34	15.34	15.03	30.14	94.73	62.26	93.88	61.64	223.1	93.11	61.19	61.19	61.19	164.9	61.19	196.0	30.33	30.33	15.37	15.37
14	15.30	15.30	15.30	30.14	45.51	93.11	93.88	223.1	93.11	61.19	61.19	61.19	61.19	164.2	164.9	196.0	15.37	15.37	30.24	30.33
13	15.03	15.03	30.66	30.66	30.81	30.33	93.11	223.1	93.11	61.19	61.19	30.33	164.9	92.04	126.6	196.0	61.19	61.19	109.6	109.6
12	15.03	15.03	30.66	30.66	30.81	30.81	61.19	223.1	61.19	61.19	61.19	45.62	164.9	92.04	61.19	109.6	109.6	196.0	164.9	92.04
11	15.03	15.03	30.66	30.14	30.24	30.81	61.19	223.1	61.19	61.19	61.19	164.9	164.9	92.04	109.6	109.6	93.11	61.19	196.0	164.9
10	30.23	30.23	30.76	30.23	30.33	30.33	93.11	223.1	164.9	92.04	61.19	164.9	92.04	92.04	45.67	61.19	93.11	61.19	196.0	45.67
9	30.76	30.76	30.23	15.42	61.64	45.67	68.68	222.6	164.4	164.9	30.33	126.6	93.88	61.64	61.64	93.88	93.11	93.11	93.11	223.1
8	30.76	30.76	30.23	61.19	61.64	45.67	68.68	251.0	139.6	139.6	126.0	61.19	93.11	61.19	93.11	61.19	61.19	61.19	61.19	223.1
7	30.76	15.34	61.64	61.64	30.33	45.67	45.67	251.0	139.6	139.6	109.9	109.6	61.19	61.19	93.11	61.19	61.19	61.19	61.19	223.1
6	15.08	15.08	225.4	225.4	223.1	70.69	45.67	251.0	222.6	139.6	91.75	92.04	109.6	109.6	61.19	61.19	61.19	61.19	210.4	216.8
5	92.04	143.8	61.64	62.36	31.46	223.1	223.1	140.0	140.0	223.1	222.6	223.1	94.73	109.6	61.19	61.19	109.6	164.9	61.19	61.19
4	143.8	92.04	61.19	30.91	15.34	30.86	109.6	140.0	68.68	140.0	92.04	164.9	164.9	223.1	223.1	169.7	109.6	223.1	223.1	230.2
3	143.8	92.04	15.03	15.03	62.04	30.24	109.6	61.19	45.67	61.19	92.04	92.04	164.9	164.9	92.04	223.1	223.1	223.1	45.67	62.36
2	61.05	164.9	15.03	62.04	62.04	30.24	109.6	61.19	93.11	93.11	92.04	68.68	92.04	92.04	164.9	164.9	164.9	223.1	109.6	62.36
1	109.4	45.52	15.03	62.04	62.04	30.24	109.6	45.67	93.11	61.19	164.9	92.04	92.04	92.04	140.0	92.04	92.71	93.88	196.0	46.54

# IED Uses: Support Modeling

Outputs spatially and temporally resolved data

**Source Name:** All Sources

**Region:** Metropolitan Region of Metropolis

**Class:** On-Road Mobile: Passenger Vehicle

**Scenario:** All Passenger Vehicles Electric Beginning 2015

**Flow Material:** Volatile Organic Compounds (VOC)

**Calculation Time:** 2012 - January through March/Weekday - 12:00

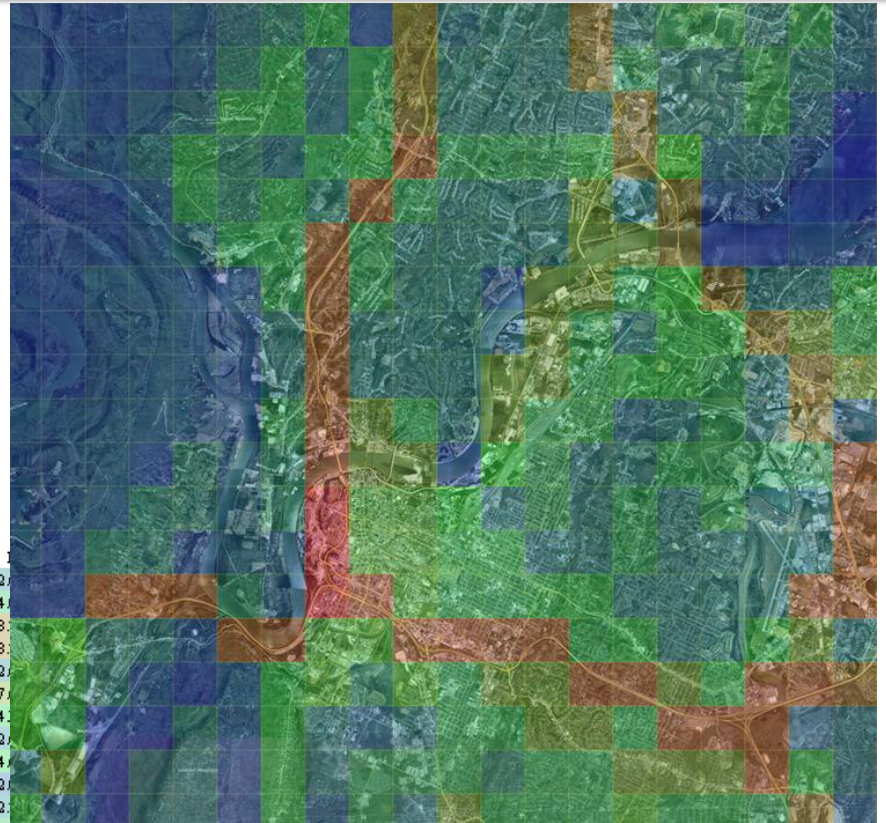
**Number of Processes:** 24

**Total Emissions in Region:** 1,592 kilogram

	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14
19	0.644	0.627	0.644	0.644	1.373	2.060	2.746	4.119	0.644	8.966	2.053	2.737	2.737	8.966	2.053
18	0.644	0.627	0.644	0.644	1.373	2.746	4.214	1.931	4.013	8.966	2.676	2.676	2.676	8.763	4.013
17	1.287	1.254	0.644	1.373	2.060	4.214	4.119	1.881	4.106	8.763	2.676	2.676	2.676	2.676	8.763
16	0.620	1.241	1.241	2.060	4.214	2.810	1.931	4.106	4.483	9.859	4.013	4.013	4.013	4.682	8.763
15	0.644	0.644	0.620	1.241	4.119	2.746	4.106	2.737	9.859	4.013	2.676	2.676	2.676	7.668	2.676
14	0.637	0.637	0.637	1.241	1.985	4.013	4.106	9.859	4.013	2.676	2.676	2.676	2.676	7.587	7.587
13	0.620	0.620	1.274	1.274	1.241	1.338	4.013	9.859	4.013	2.676	2.676	1.338	7.668	7.668	4.013
12	0.620	0.620	1.274	1.274	1.241	1.241	2.676	9.859	2.676	2.676	2.676	2.191	7.668	4.382	2.676
11	0.620	0.620	1.274	1.241	1.324	1.241	2.676	9.859	2.676	2.676	2.676	7.668	7.668	4.382	4.382
10	1.254	1.254	1.287	1.254	1.338	1.338	4.013	9.859	7.668	4.382	2.676	7.668	4.382	4.382	2.676
9	1.287	1.287	1.254	0.627	2.737	2.007	3.286	10.06	7.828	7.668	1.338	5.351	4.106	2.737	2.676
8	1.287	1.287	1.254	2.676	2.737	2.007	3.286	11.20	6.709	6.709	5.463	2.676	4.013	2.676	4.013
7	1.287	0.644	2.737	2.737	1.338	2.007	2.007	11.20	6.709	6.709	4.780	4.682	2.676	2.676	2.676
6	0.627	0.627	10.09	10.09	9.859	3.286	2.007	11.20	10.06	6.709	4.473	4.382	4.682	2.676	2.676
5	4.382	6.020	2.737	2.508	1.287	9.859	9.859	6.573	6.573	9.859	10.06	9.859	9.859	4.382	4.682
4	6.020	4.382	2.676	1.254	0.644	1.373	4.682	6.573	3.286	6.573	4.382	7.668	7.668	9.859	9.859
3	6.020	4.382	0.620	0.620	2.717	1.324	4.682	2.676	2.007	2.676	4.382	4.382	7.668	7.668	4.382
2	2.676	7.668	0.620	2.717	2.717	1.324	4.682	2.676	4.013	4.013	4.382	3.286	4.382	4.382	7.668
1	4.682	1.881	0.620	2.717	2.717	1.324	4.682	2.007	4.013	2.676	7.668	4.382	4.382	6.573	4.382
0	1.239	0.627	2.574	2.746	2.746	1.324	2.007	2.007	2.007	2.676	4.382	7.668	4.382	6.573	3.286

Show Map

show notes/errors - ☒  
color table - ☒  
hold high/low coloring values - ☐



# IED Uses: Support Planning

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The design of the system enables answering such questions as:

- ✧ How would a rapid transit system affect fuel use? criteria pollutants? global warming emissions?
- ✧ What are the top categories of GHG emissions today and projected in the future?
- ✧ What are the differences in energy use and emissions from moving towards a natural gas fleet or an electric fleet?

# IED Uses: Support Enforcement

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IED is designed to track the emissions and energy from point sources, and return data from queries such as:

- ✧ What is ABC Company's emissions this year?  
Last year?
- ✧ Is ABC Company exceeding its emissions cap?
- ✧ How many credits are available in this location/area?



# IED Status & Future

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- ✧ Base System Developed
- ✧ Currently populating
- ✧ Will be used to support effective/integrated c participating cities starting Mexico City, and Guad
- ✧ Training session planned begin that process



# Thank You!

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